Tips from Industry: The Importance of Particle Size for Cosmetic Products

H Squared Industries & HORIBA

Introduction: CSO for H Squared Industries-Chris Harrison

- *Chris has a Bachelor's Degree in Biological Sciences from Augustana College. He has over 25 years of experience in the biotechnology, pharmaceutical, cosmetic, brewing, and hemp industries. He is a founder of H Squared Industries, a Portland, Oregon-based consulting firm. For the last 6 years Chris has specialized in Nanotechnologies related to active ingredient delivery systems. His other areas of expertise include; cosmetic formulation, beverage formulation, maximizing bioavailability of active ingredients, terpene chemistry and formulation concepts, operational oversight of Contract Manufacturers, Microfluidics, and Particle Size Analysis.*

- *H Squared Industries operates a contract Particle Size Analysis lab in Hillsboro, Oregon and utilizes a HORIBA LA-960S2 Laser Diffraction Particle Size Analyzer. We are recognized by HORIBA as a Preferred Provider for Contract Particle Size Analysis in the Hemp Industry. We also perform these services in other like Nanotechnology related industries.*

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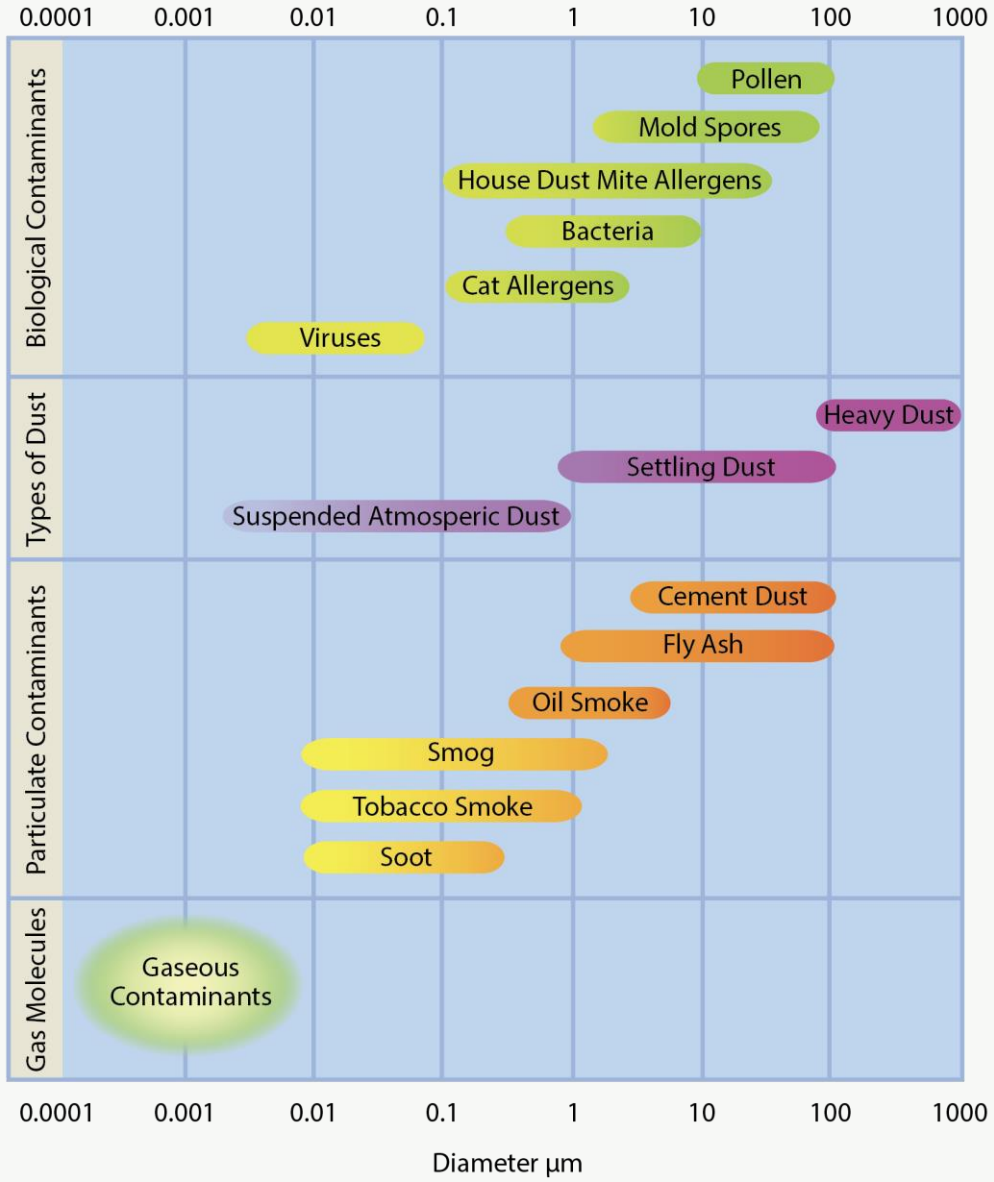
Particle Size Basics

- Particle Size Distribution is responsible for up to 80% of the composition of a product
- Particles can be thought of as the “blueprint” of a product
- Understanding scale: diameter in micrometers (µm), nanometers > **see infographic**
- Example: A strand of Human DNA is 2.5 nanometers in diameter
- Nanoscopic scale > 1-100 nanometers

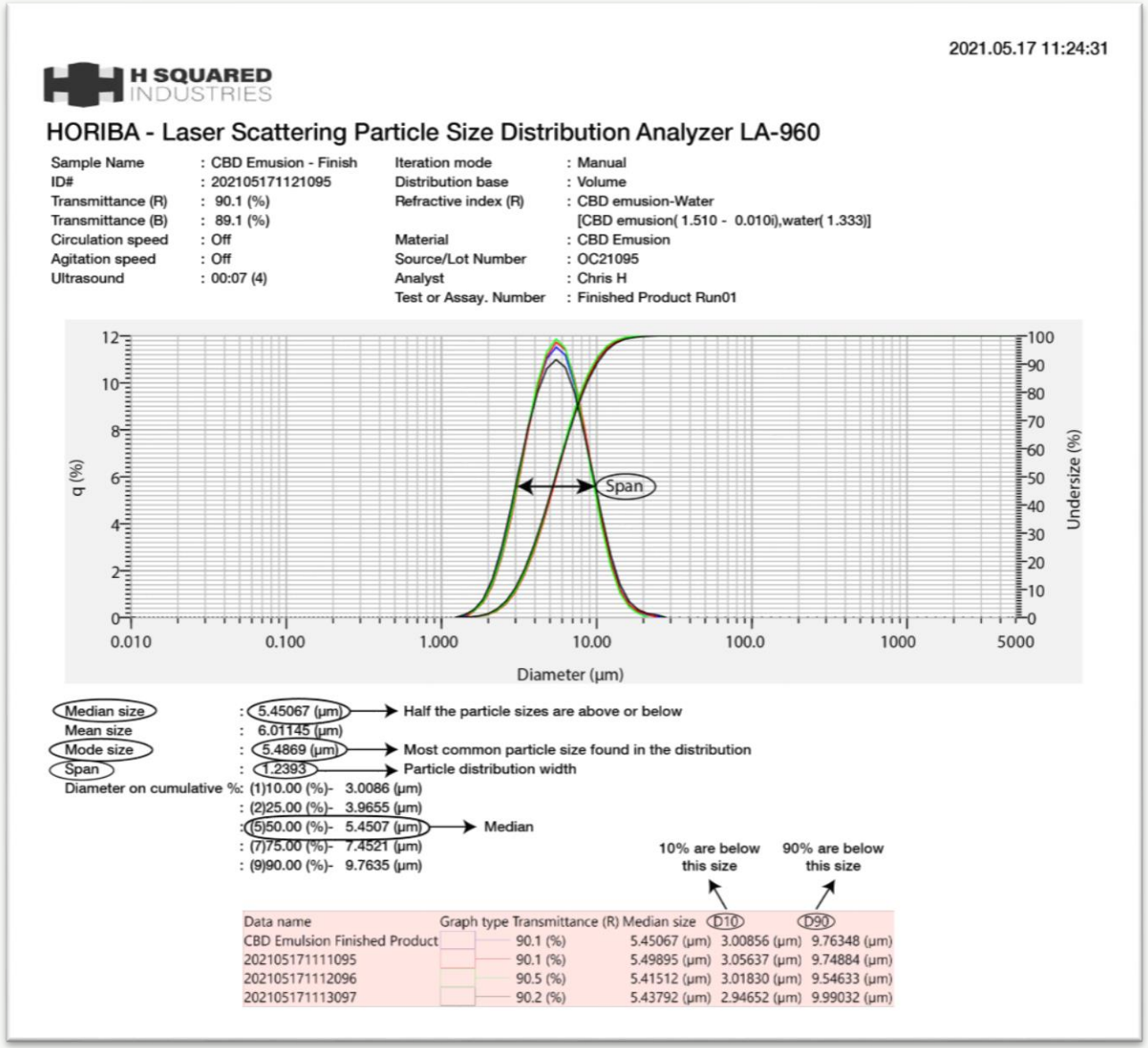


Why the HORIBA LA-960S2?

- The HORIBA LA-960S2 can measure Particle Sizes from 10 nanometers to 5 millimeters
- The LA-960S2 has wet and dry capabilities: emulsions, creams, gels, pastes, suspensions, powder, soil, other like materials > flexible
- Easily modified for additional capabilities > imaging, powder feed
- Software ease of use > training sets client up for success
- Technical support is unmatched

Particle Size Terminology

- Terms: Median, D50, D90, D10, Span, Mode > **see example data**
- More detailed information in several past webinars offered by HORIBA
- Prior HORIBA webinars:
- http://bit.ly/particlewebinars



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HORIBA - Laser Scattering Particle Size Distribution Analyzer LA-960

Sample Name	: CBD Emusion - Finish	Iteration mode	: Manual
ID#	: 202105171121095	Distribution base	: Volume
Transmittance (R)	: 90.1 (%)	Refractive index (R)	: CBD emusion-Water
Transmittance (B)	: 89.1 (%)		[CBD emusion(1.510 - 0.010i),water(1.333)]
Circulation speed	: Off	Material	: CBD Emusion
Agitation speed	: Off	Source/Lot Number	: OC21095
Ultrasound	: 00:07 (4)	Analyst	: Chris H
		Test or Assay. Number	: Finished Product Run01

Median size : 5.45067 (µm) → Half the particle sizes are above or below
Mean size : 6.01145 (µm)
Mode size : 5.4869 (µm) → Most common particle size found in the distribution
Span : 1.2393 → Particle distribution width
Diameter on cumulative %: (1)10.00 (%)- 3.0086 (µm)
: (2)25.00 (%)- 3.9655 (µm)
: (5)50.00 (%)- 5.4507 (µm) → Median
: (7)75.00 (%)- 7.4521 (µm)
: (9)90.00 (%)- 9.7635 (µm)

10% are below this size
90% are below this size

Data name	Graph type	Transmittance (R)	Median size	D10	D90
CBD Emulsion Finished Product		90.1 (%)	5.45067 (µm)	3.00856 (µm)	9.76348 (µm)
202105171111095		90.1 (%)	5.49895 (µm)	3.05637 (µm)	9.74884 (µm)
202105171112096		90.5 (%)	5.41512 (µm)	3.01830 (µm)	9.54633 (µm)
202105171113097		90.2 (%)	5.43792 (µm)	2.94652 (µm)	9.99032 (µm)

Why is Particle Size Analysis important for Cosmetic Applications?

- Many Cosmetic products include particulates and emulsions
- Examples: Facial powders, lipstick, sunscreen, creams, lotions
- Particle Size affects light reflection and diffusion
- Color and shading > **see Bronzer data**

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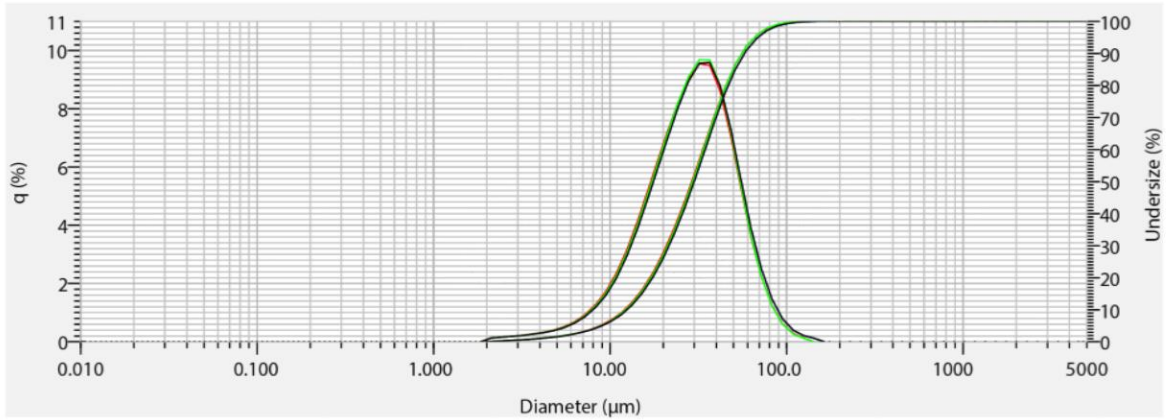
HORIBA - Laser Scattering Particle Size Distribution Analyzer LA-960

Sample Name	: Bronzer1	Iteration mode	: Auto
ID#	: 202107131122270	Distribution base	: Volume
Transmittance (R)	: 92.5 (%)	Refractive index (R)	: Bronzer ipa
Transmittance (B)	: 95.0 (%)		[Dimethicone IPA(1.570 - 0.100i),isopropanol(1.378)]
Circulation speed	: 5	Material	: bronzer ipa
Agitation speed	: 4	Source/Lot Number	:
Ultrasound	: 00:01 (4)	Analyst	: Matt H
		Test or Assay. Number	: Run1



Median size	: 29.91101 (μm)
Mean size	: 33.22552 (μm)
Mode size	: 36.4594 (μm)
Span	: 1.5168
Diameter on cumulative %	: (1)10.00 (%)- 12.4550 (μm)
	: (2)20.00 (%)- 17.3864 (μm)
	: (3)30.00 (%)- 21.5362 (μm)
	: (4)40.00 (%)- 25.6656 (μm)
	: (5)50.00 (%)- 29.9110 (μm)
	: (6)60.00 (%)- 34.4769 (μm)
	: (7)70.00 (%)- 39.7677 (μm)
	: (8)80.00 (%)- 46.7154 (μm)
	: (9)90.00 (%)- 57.8230 (μm)

Data name	Graph type	Transmittance (R)	Median size	D10	D90
202107131122270		92.5 (%)	29.91101 (μm)	12.45495 (μm)	57.82304 (μm)
202107131122268		92.4 (%)	28.98090 (μm)	12.08100 (μm)	55.87347 (μm)
202107131122269		92.6 (%)	29.30453 (μm)	12.25143 (μm)	55.88535 (μm)
202107131122270		92.5 (%)	29.91101 (μm)	12.45495 (μm)	57.82304 (μm)

Why is Particle Size Analysis important for Cosmetic Applications?

- Emulsion stability tied to Particle Size and Distribution
- Particle Size impacts bioavailability; <100nm penetrates the epidermis more easily
- Affects active ingredient delivery
- Texture and application feel of Cosmetics can be affected

Why is Particle Size Analysis important for Cosmetic Applications?

- High-end Cosmetic companies have PSAs in house for Formulation traceability, to characterize Raw Materials, and for QC on finished goods
- Highly confidential data > proprietary, potential IP
- Can assist with Proof of Concept
- See the following comparison between products at two different price points

Less Homogenous~Similar IL

- Stability impacted, texture affected, lower price (fill date 5/2021)

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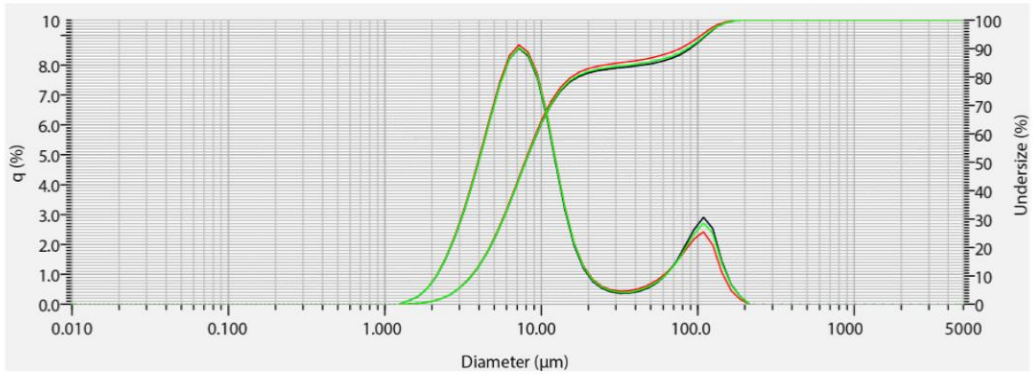
HORIBA - Laser Scattering Particle Size Distribution Analyzer LA-960

Sample Name	:	Iteration mode	: Manual
ID#	: 202106261744232	Distribution base	: Volume
Transmittance (R)	: 90.4 (%)	Refractive index (R)	: Eye Cream
Transmittance (B)	: 90.1 (%)		[Eye Cream +Collagen(1.500 - 0.100i),water(1.333)]
Circulation speed	: 5	Material	: Eye Cream + Collagen
Agitation speed	: 7	Source/Lot Number	: VCEC-20227-1
Ultrasound	: Off	Analyst	: Matt H
		Test or Assay. Number	: Run 1



Median size	: 7.93198 (µm)	Data name	Graph type	Transmittance (R)	Median size	D10	D90
Mean size	: 23.01753 (µm)	202106261744232		90.4 (%)	7.93198 (µm)	3.58395 (µm)	89.80443 (µm)
Mode size	: 7.1971 (µm)	202106261743230		90.4 (%)	7.82974 (µm)	3.55729 (µm)	77.39455 (µm)
Span	: 10.8700	202106261744231		90.4 (%)	7.91899 (µm)	3.57590 (µm)	86.27561 (µm)
Diameter on cumulative %	: (1)10.00 (%)- 3.5839 (µm)	202106261744232		90.4 (%)	7.93198 (µm)	3.58395 (µm)	89.80443 (µm)
	: (2)25.00 (%)- 5.2167 (µm)						
	: (5)50.00 (%)- 7.9320 (µm)						
	: (7)75.00 (%)- 13.2338 (µm)						
	: (9)90.00 (%)- 89.8044 (µm)						

More Homogenous~Similar IL

- Better stability, better texture, higher price (fill date 4/2021)

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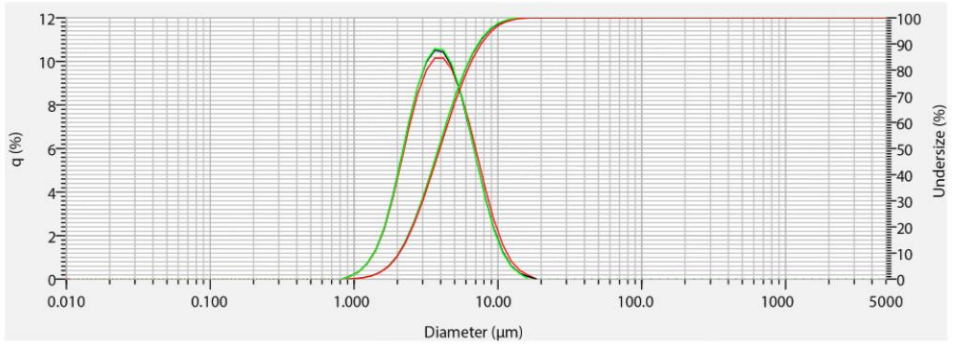
HORIBA - Laser Scattering Particle Size Distribution Analyzer LA-960

Sample Name	:	Iteration mode	: Auto
ID#	: 202107010902246	Distribution base	: Volume
Transmittance (R)	: 91.0 (%)	Refractive index (R)	: Almond oil
Transmittance (B)	: 90.4 (%)		[Almond oil(1.460 - 0.100i),water(1.333)]
Circulation speed	: 4	Material	: Night Cream w/ Rosepene
Agitation speed	: 4	Source/Lot Number	: 128156
Ultrasound	: 00:07 (5)	Analyst	: Matt H
		Test or Assay. Number	: Run 1



Median size	: 3.86241 (µm)	Data name	Graph type	Transmittance (R)	Median size	D10	D90
Mean size	: 4.35180 (µm)	202107010902246		91.0 (%)	3.86241 (µm)	2.05046 (µm)	7.32916 (µm)
Mode size	: 3.6587 (µm)	202107010902244		91.1 (%)	3.95832 (µm)	2.06896 (µm)	7.63877 (µm)
Span	: 1.3667	202107010902245		91.1 (%)	3.86252 (µm)	2.05551 (µm)	7.26853 (µm)
Diameter on cumulative %	: (1)10.00 (%)- 2.0505 (µm)	202107010902246		91.0 (%)	3.86241 (µm)	2.05046 (µm)	7.32916 (µm)
	: (2)20.00 (%)- 2.5294 (µm)						
	: (3)30.00 (%)- 2.9607 (µm)						
	: (4)40.00 (%)- 3.3937 (µm)						
	: (5)50.00 (%)- 3.8624 (µm)						
	: (6)60.00 (%)- 4.3990 (µm)						
	: (7)70.00 (%)- 5.0497 (µm)						
	: (8)80.00 (%)- 5.9124 (µm)						
	: (9)90.00 (%)- 7.3292 (µm)						

Emulsions~Deeper Dive

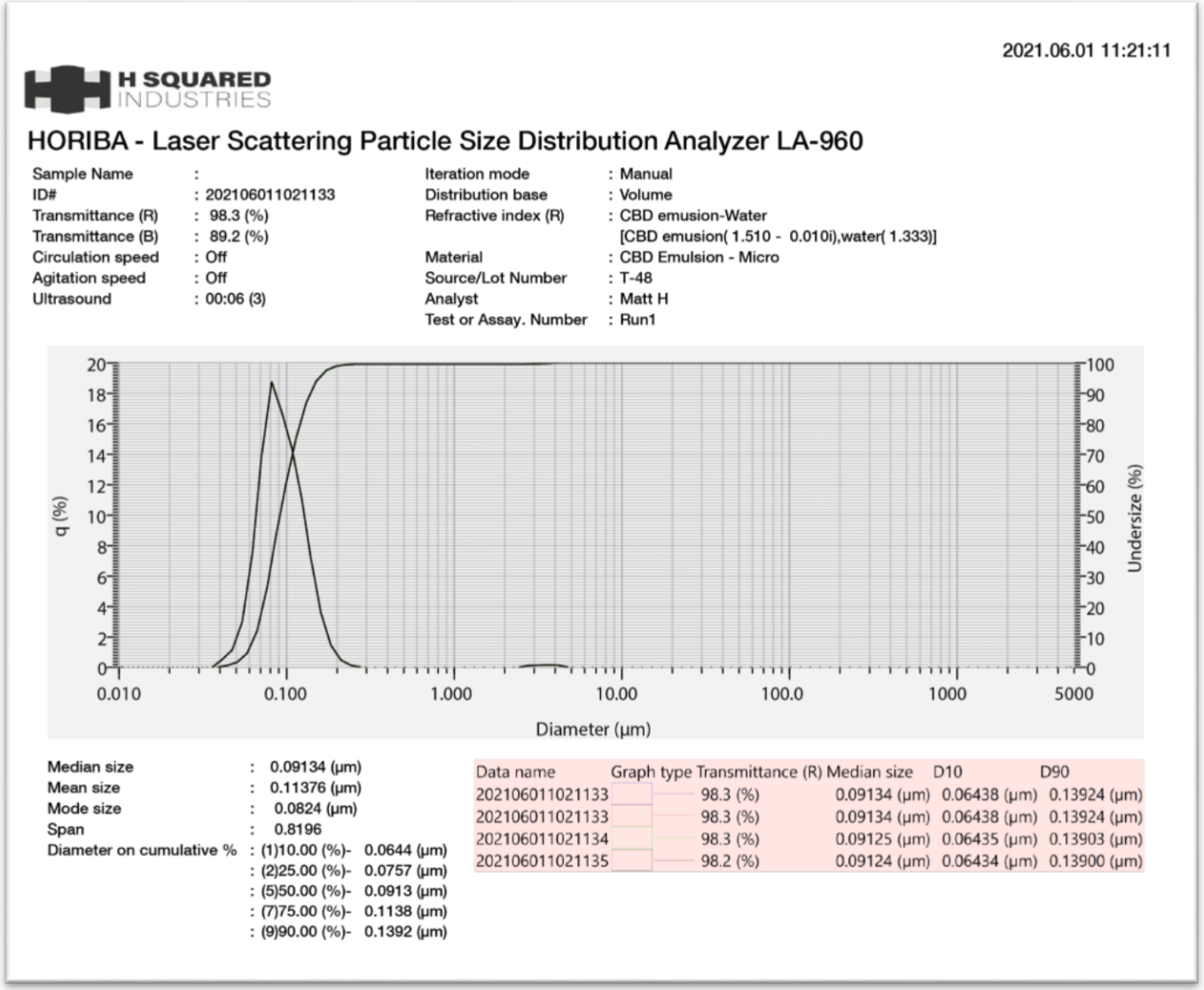
- **Definition:** A fine dispersion of minute droplets of one liquid in another in which it is not soluble or miscible
- When unstable they will separate into multiple layers
- Smaller Particle Sizes are more stable
- Particle Size Distribution can indicate stability

Emulsions~Deeper Dive

- Emulsifiers are surfactants that stabilize emulsions > decrease surface tension between oil and water
- They coat droplets/particles within an emulsion and prevent coalescing
- Emulsifiers are used in conjunction with mechanical means like high shear agitation, Microfluidics, or sonication
- Common in Cosmetics and Beverages > making an oil “water soluble”

CBD Emulsions

- CBD Emulsions are oil in water emulsions > **see example data**
- Cosmetic and Beverage applications seeing tremendous growth
- Formulations should differ based on application
- Particle Size and Distribution of the dispersed phase (Oil-CBD) affects stability and bioavailability
- Particle Size impacts delivery of the active ingredient



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H SQUARED INDUSTRIES

HORIBA - Laser Scattering Particle Size Distribution Analyzer LA-960

Sample Name	:	Iteration mode	: Manual
ID#	: 202106011021133	Distribution base	: Volume
Transmittance (R)	: 98.3 (%)	Refractive index (R)	: CBD emusion-Water
Transmittance (B)	: 89.2 (%)		[CBD emusion(1.510 - 0.010i),water(1.333)]
Circulation speed	: Off	Material	: CBD Emulsion - Micro
Agitation speed	: Off	Source/Lot Number	: T-48
Ultrasound	: 00:06 (3)	Analyst	: Matt H
		Test or Assay. Number	: Run1

Median size	:	0.09134 (µm)
Mean size	:	0.11376 (µm)
Mode size	:	0.0824 (µm)
Span	:	0.8196
Diameter on cumulative %	: (1)10.00 (%)-	0.0644 (µm)
	: (2)25.00 (%)-	0.0757 (µm)
	: (5)50.00 (%)-	0.0913 (µm)
	: (7)75.00 (%)-	0.1138 (µm)
	: (9)90.00 (%)-	0.1392 (µm)

Data name	Graph type	Transmittance (R)	Median size	D10	D90
202106011021133		98.3 (%)	0.09134 (µm)	0.06438 (µm)	0.13924 (µm)
202106011021133		98.3 (%)	0.09134 (µm)	0.06438 (µm)	0.13924 (µm)
202106011021134		98.3 (%)	0.09125 (µm)	0.06435 (µm)	0.13903 (µm)
202106011021135		98.2 (%)	0.09124 (µm)	0.06434 (µm)	0.13900 (µm)

CBD Emulsions

- **See example >** Data overlay of a Raw CBD Emulsion and the Finished CBD Cream product
- CBD Emulsion quality will differ based on the formulation, mechanical means of emulsification, and feedstock (CBD Oil)
- Feedstock quality affects the emulsion > waxes and lipids can interfere
- Our experience: Most Emulsions have a larger Particle Size and Distribution than thought by the client

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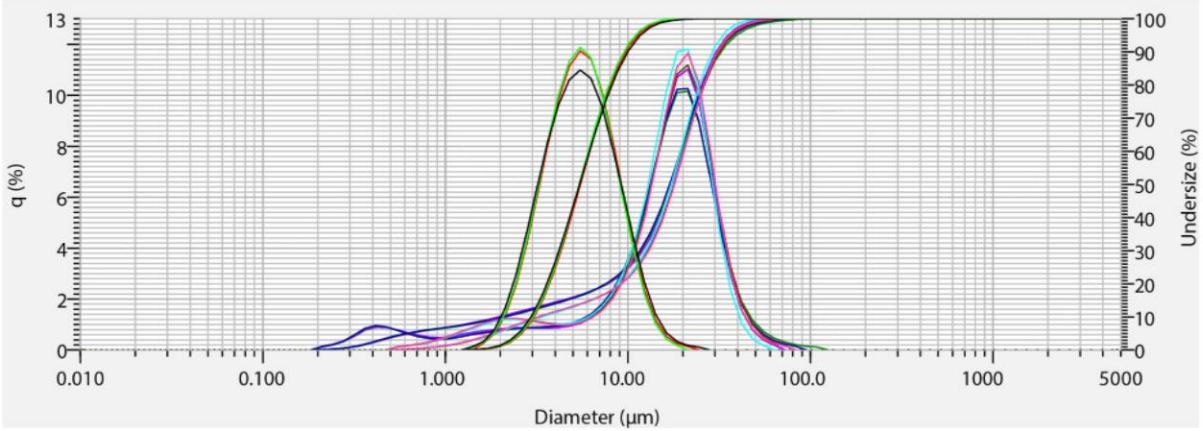
H SQUARED INDUSTRIES

HORIBA - Laser Scattering Particle Size Distribution Analyzer LA-960

Sample Name	: CBD Emusion - Micro	Iteration mode	: Manual
ID#	: 202105171156105	Distribution base	: Volume
Transmittance (R)	: 92.9 (%)	Refractive index (R)	: CBD emusion-Water
Transmittance (B)	: 91.5 (%)		[CBD emusion(1.510 - 0.010i),water(1.333)]
Circulation speed	: Off	Material	: Raw emulsion
Agitation speed	: Off	Source/Lot Number	: OEFG21090
Ultrasound	: 00:07 (4)	Analyst	: Chris H
		Test or Assay. Number	: T90 test3



Median size	: 17.32084 (μm)
Mean size	: 17.37356 (μm)
Mode size	: 21.1858 (μm)
Span	: 1.6467
Diameter on cumulative %	: (1)10.00 (%)- 1.9973 (μm)
	: (2)25.00 (%)- 10.1954 (μm)
	: (5)50.00 (%)- 17.3208 (μm)
	: (7)75.00 (%)- 23.7849 (μm)
	: (9)90.00 (%)- 30.5195 (μm)

Data name	Graph type	Transmittance (R)	Median size	D10	D90
202105171156105		92.9 (%)	17.32084 (μm)	1.99725 (μm)	30.51947 (μm)
202105171111095		90.1 (%)	5.49895 (μm)	3.05637 (μm)	9.74884 (μm)
202105171112096		90.5 (%)	5.41512 (μm)	3.01830 (μm)	9.54633 (μm)
202105171113097		90.2 (%)	5.43792 (μm)	2.94652 (μm)	9.99032 (μm)
202105171143099		94.9 (%)	17.96516 (μm)	3.26438 (μm)	31.01727 (μm)
202105171143100		94.9 (%)	17.25396 (μm)	3.42373 (μm)	29.05361 (μm)
202105171145101		94.9 (%)	17.85328 (μm)	3.37398 (μm)	31.69490 (μm)
202105171155103		92.7 (%)	16.93296 (μm)	2.10952 (μm)	31.52964 (μm)
202105171155104		92.7 (%)	17.10353 (μm)	2.16716 (μm)	32.39742 (μm)
202105171156105		92.9 (%)	17.32084 (μm)	1.99725 (μm)	30.51947 (μm)

Stability Studies~

- EVIO Labs & H Squared Industries > planning CBD Emulsion Stability Studies as they correlate to Particle Size Data (including Raw Emulsions and Finished Goods)
- Working with a Cosmetic Contract Manufacturer on Particle Size Stability predictors
- Working with a bulk CBD Emulsion Manufacturer (powder and wet) to provide per Batch data sets
- Goal 1: Provide a projection of product appearance on the shelf over time in real time
- Goal 2: Add Particle Size Analysis as an additional layer of QC for CBD products (equivalent to Potency, Pesticides, Residual Solvents, etc.)
- Goal 3: Utilize Particle Size Analysis in conjunction with Formulation to identify preferred production specifications

Conclusion

- Particle Size Analysis is an excellent application for a wide variety of Cosmetic products
- We have analyzed creams, gels, balms, lotions, foundations, sunscreen, lipstick and more
- Manufacturers can adhere to detailed specifications at all steps of the process
- CBD and like molecules are the next big trend
- Particle Size Analysis allows fast, replicable, and reliable data otherwise not available to manufacturers